



# National Transportation Safety Board

Washington, D.C. 20594

## Highway Accident Brief

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**Accident No.:** HWY-05-MH-023  
**Accident Type:** Frontal and sideswipe collision between a school bus and a trash truck  
**Location:** Columbia Pike near the intersection with Courthouse Road; Arlington, Virginia  
**Date and Time:** April 18, 2005; 8:40 a.m.  
**Vehicle 1:** 1999 Thomas Built 52-passenger school bus  
**Operator 1:** Arlington County, Virginia, School District  
**Vehicle 2:** 2003 Mack 4-axle truck with a Heil trash body  
**Operator 2:** AAA Recycling and Trash Removal Services  
**Injuries:** 2 fatal, 3 serious, and 4 minor

### Accident Description

Shortly before 8:40 a.m., on Monday, April 18, 2005, a 52-passenger school bus was traveling westbound on Columbia Pike (State Route 244) in Arlington County, Virginia, transporting 15 elementary school children, grades pre-K through 5, to the nearby Hoffman-Boston Elementary School. On approaching the signaled intersection with Courthouse Road, the school bus driver began moving the bus into the left turn lane (from which it would turn south onto Courthouse Road) and slowed it nearly to a stop.<sup>1</sup> As the driver turned the vehicle, its left front encroached slightly into the left lane of the eastbound side of Columbia Pike. The driver later stated<sup>2</sup> that distractions inside the bus might have affected her driving at this time. She said her attention was drawn to a student standing on a seat and to a clipboard that fell to the floor at her driving station.

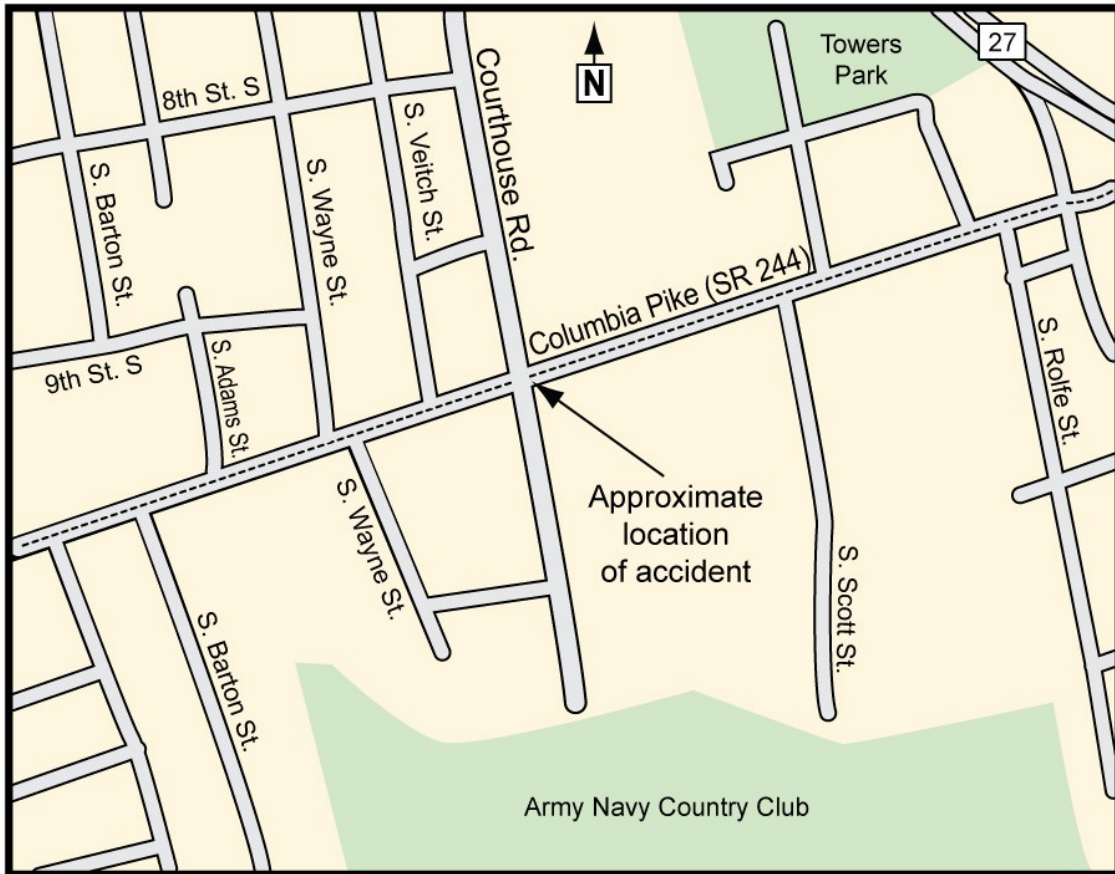
About 8:40 a.m., a 2003 Mack trash truck was traveling with the flow of traffic in the left eastbound lane on Columbia Pike, at a speed one witness who was traveling on the road in the same direction estimated to be approximately 30 mph. The truck reached the intersection with Courthouse Road, continued through it on a green signal and, according to several witnesses, deviated slightly leftward from its lane toward the yellow centerline. The truck collided with the school bus; the impact involved the front-left

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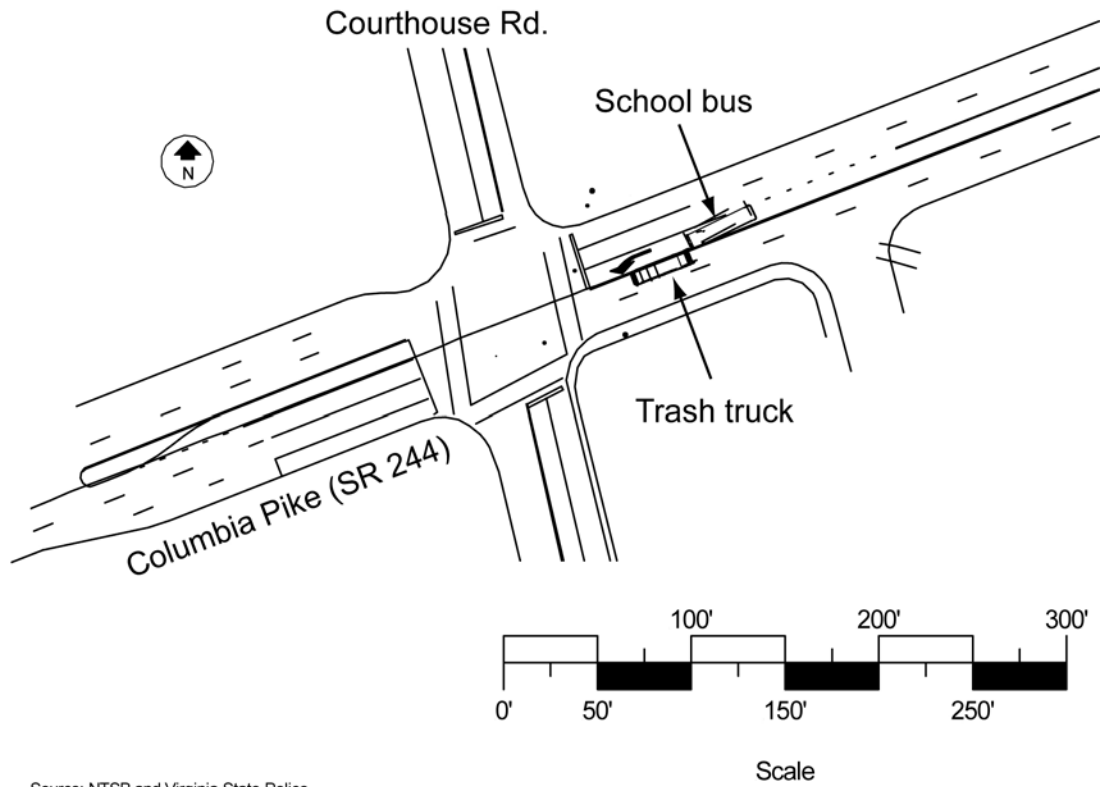
<sup>1</sup> The signal for the left turn lane was permissive green, meaning that turning was permitted but that the turning vehicle had to yield to oncoming traffic.

<sup>2</sup> The school bus driver made these statements during a brief interview conducted by the Arlington County Police at the hospital where she was treated following the accident. She declined to be interviewed by Safety Board investigators.

corners of both vehicles and a sideswipe. (See figures 1 and 2 for a map of the accident location area and a diagram representing the vehicles at the point of impact.)



**Figure 1.** Map showing the area of Arlington, Virginia, where the accident occurred.



**Figure 2.** Diagram showing the estimated positions of the school bus and the trash truck at the point of impact.

During the collision, the school bus was pushed backward, but it remained in the left turn lane following the accident. The trash truck continued eastbound about 200 feet, crossed the right eastbound lane, jumped the right curb of Columbia Pike, and came to rest. (See figure 3.)



**Figure 3.** Vehicles at rest postaccident.

One student died at the scene and one student died 3 days later in the hospital. The truck driver, school bus driver, and one student on the bus sustained serious injuries; four students sustained minor injuries; and the remaining eight students were uninjured. The bus driver, who had been wearing her seat belt, was ejected through the broken windshield when the shoulder portion of the belt was sheared in half. Emergency responders needed approximately 1 hour to extricate the trash truck driver from the truck cab because of his legs being trapped in the wreckage. The students who suffered the most severe injuries were seated behind the driver on the left side, near the front, of the bus. (See figure 4.)

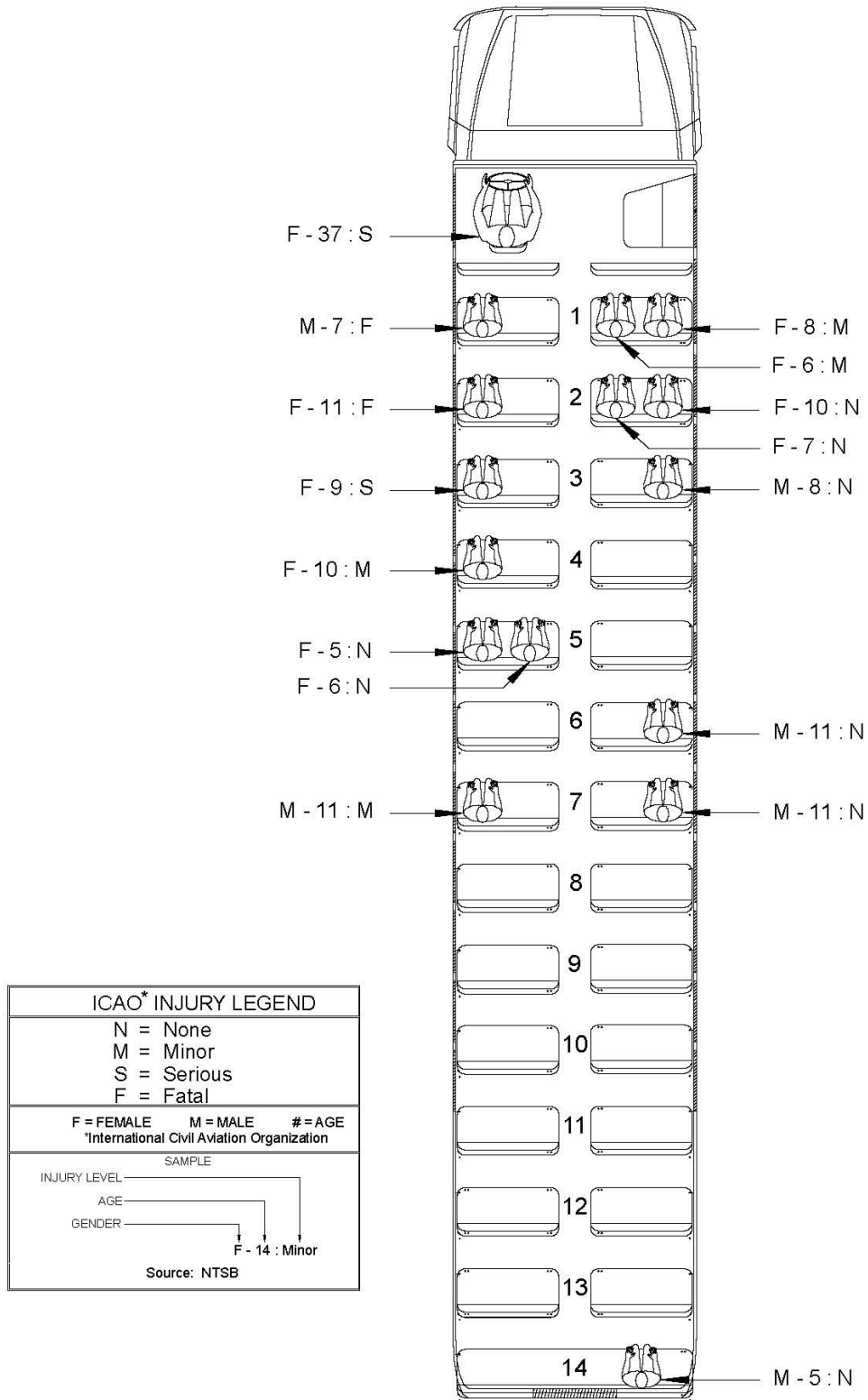


Figure 4. School bus seating and injury chart.

Weather conditions at the time of the accident were clear and dry.

The school bus sustained impact damage to its front and left side. (See figure 5.) The damage continued along the left side of the bus to near the sixth passenger row behind the driver's seat, approximately 20 feet rearward from the front bumper. Intrusion into the occupant compartment extended inboard to a depth of about 6 1/2 inches.



**Figure 5.** Damage to the school bus.

The trash truck sustained damage to its left-front corner and its hydraulic front loader arm assembly. The left fork of the trash truck's hydraulic arm was bent outward and protruded to the left of the truck's left side. (See figure 6.)





**Figure 6.** Damage to the trash truck.

## **Vehicles**

### ***School Bus***

The school bus was a 1999 52-passenger transit-style<sup>3</sup> school bus manufactured by Thomas Built Buses, Inc. The bus had a gross vehicle weight rating of 36,360 pounds, a body length of 36 feet, 3 inches, an overall body height of approximately 10 feet, and a body width of 8 feet. The accident bus met the applicable requirements of Federal Motor Vehicle Safety Standard (FMVSS) 221 for design strength.<sup>4</sup>

The tires were inflated within an acceptable range of manufacturer-recommended tire pressures and had adequate tread depths. During the postaccident inspection, investigators found the steering system of the school bus to be solidly connected. The bus was equipped with antilock brakes. The pneumatic braking system was configured

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<sup>3</sup> A transit-style school bus consists of a body installed upon the chassis, with the engine mounted in the front, midsection, or rear. These vehicles have a gross vehicle weight rating of more than 10,000 pounds and are designed to carry more than 10 passengers. The entrance door and driver's seat are forward of the front axle.

<sup>4</sup> FMVSS 221, "School Bus Body Joint Strength," establishes requirements for the strength of the body panel joints in school bus bodies. The purpose of this standard is to reduce deaths and injuries resulting from the structural collapse of school bus bodies during crashes.

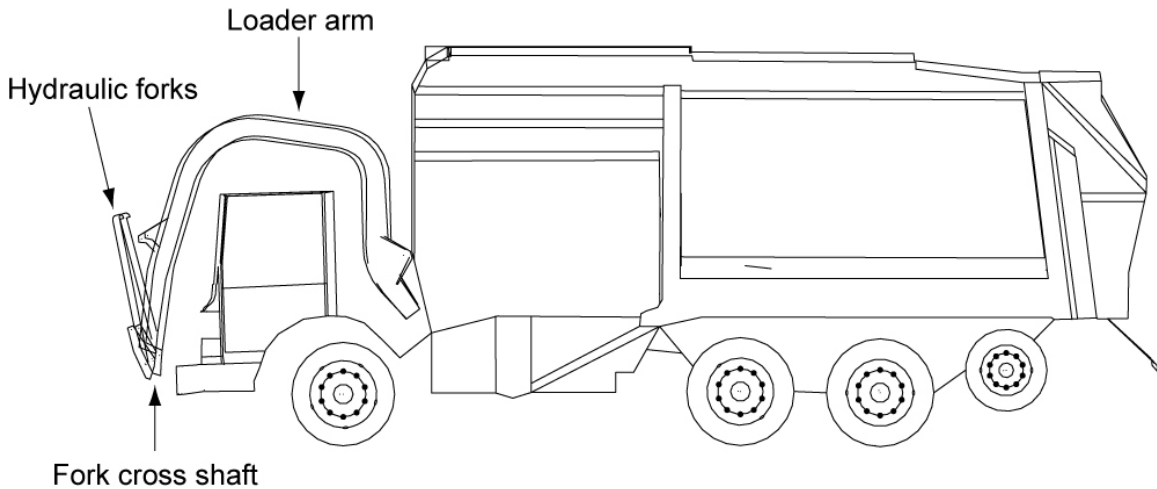
appropriately and was functional during the inspection. All brakes were within adjustment limits.

The school bus did not have an event data recorder, and its engine's electronic control module was not equipped with data recording features.

### **Trash Truck**

The trash truck was a 2003 Mack Trucks, Inc., 4-axle truck with a Heil Environmental Industries, Ltd. (Heil), trash body. This type of vehicle undergoes a two-stage manufacturing process in which the chassis is produced by a truck manufacturer (Mack) and then is sent to another manufacturer (Heil), which equips the vehicle with the refuse loading and hauling body. According to specifications, the vehicle had a gross vehicle weight rating of 77,000 pounds and was 33 feet long, 8 feet wide, and 14 feet, 10 inches, high with the trash-loading arm assembly raised and 13 feet high with it lowered. The hydraulic arm's width matched the width of the vehicle body, at 8 feet.

The vehicle's hydraulic front-loading arm assembly was designed to pick up dumpsters, raise them above the truck, and empty their contents into the back of the truck. According to Heil, the recommended in-transit position for this assembly was with the fork cross shaft (bottom) of the arm "slightly below cab windshield"<sup>5</sup> to ensure visibility through the windshield and enable the vehicle to meet road height restrictions. The recommended in-transit position for the forks (which retract down from the two sides of the arm) was that they be folded up into the arm. (See figure 7.)



**Figure 7.** Diagram of an exemplar trash truck with loader arm positioned below cab windshield, as recommended by Heil for transit. The forks in this diagram are approximately halfway between being folded into the arm and being fully extended.

<sup>5</sup> Heil *Operator's Manual*, MR-75029-305, p. 24.



The truck driver stated that he had positioned the truck's arm above the headlights, which would put it forward of the bumper and a little below the windshield. Postaccident examination indicated that the forks were neither fully folded nor fully extended. (Damage to the forks made it difficult to determine their preaccident position.)

The tires were inflated within an acceptable range of manufacturer-recommended tire pressures and had adequate tread depths. Postaccident disassembly of the steering gearbox showed no internal problems with the component. The pneumatic braking system, although damaged by the crash, was configured appropriately. The left second axle, left third axle, and right fourth axle brakes were out of adjustment.<sup>6</sup>

The trash truck did not have an event data recorder but was equipped with advanced electronic engine control technology capable of recording limited accident information. However, the recorded incident data available postaccident were unrelated to the collision and appear to concern routine operational procedures. The impact with the school bus probably did not produce a strong enough crash pulse to reduce the vehicle's speed or generate a change in engine speed sufficient to trigger the incident-recording function of the installed technology.

## **Motor Carriers**

### ***AAA Recycling and Trash Removal Services***

AAA Recycling and Trash Removal Services (AAA), an authorized interstate, for-hire, motor carrier that operates in Virginia and the District of Columbia, owned the trash truck. AAA was incorporated in October 1974. The majority of the carrier's business is intrastate trash removal operations in Virginia. At the time of the accident, AAA employed about 300 full-time drivers and had a fleet of about 300 trash trucks of various sizes. AAA drivers are assigned regular routes; they work 5 days a week and some half days on Saturdays. The Federal Motor Carrier Safety Administration's (FMCSA's) Motor Carrier Management Information System (MCMIS) roadside inspection data for AAA for the 12 months preceding the accident indicated a 4-percent out-of-service rate for drivers and a 12-percent out-of-service rate for vehicles. FMCSA roadside inspection data for 2004 indicate national out-of-service rates for drivers and vehicles as 6.7 percent and 23.6 percent, respectively.<sup>7</sup> AAA had not received a compliance review by the FMCSA or the State of Virginia before this accident.<sup>8</sup> The

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<sup>6</sup> The brakes being out of adjustment would have placed the trash truck out of service had it been inspected; however, there is no evidence that the trash truck driver attempted braking prior to the crash. The brake adjustment levels would not have interfered with normal stopping ability.

<sup>7</sup> From the FMCSA's webpage for "Analysis and Information," providing roadside inspection information at <<http://www.ai.fmcsa.dot.gov/programmeasures/RI/NR/NAS/Report.asp?FC=C&RF=T>>, accessed December 14, 2006.

<sup>8</sup> MCMIS records indicated that safety evaluation area values from roadside inspections placed AAA in category H (the highest safety rating). Consequently, the FMCSA would not have prioritized AAA to receive a compliance review.

FMCSA conducted a postaccident compliance review of AAA on April 25, 2005, which resulted in a satisfactory rating.

### ***Arlington County School District***

The Arlington County School District operated the school bus. The district comprises 3 high schools, 5 middle schools, 22 elementary schools, 3 alternative schools, 1 secondary program school, 1 family center, and 1 career center. At the time of the accident, the district employed 102 full-time bus drivers and 7 substitute drivers; drivers' contracts were renewed annually. The school bus fleet consisted of 100 transit-style school buses (the configuration of the accident bus) and 24 special needs buses.

## **Highway**

Columbia Pike in the vicinity of the accident is a straight, five-lane, undivided road.<sup>9</sup> The width of the paved portion is 58 feet, measured from the north curb face to the south curb face. The paved area consists of a 10-foot-wide center turn lane, four 11-foot-wide travel lanes (two for eastbound and two for westbound traffic), and two 2-foot-wide gutter pans, one adjacent to each curb face.<sup>10</sup>

A solid, double, yellow lane marking, approximately 1 foot wide, separates the center turn lane from the adjacent eastbound travel lane. The center turn lane pavement is marked with two solid, white left-turn arrow markers.

According to the Virginia Department of Transportation, the average daily traffic on the section of Columbia Pike in the vicinity of the accident was approximately 30,000 vehicles.

The Arlington County Department of Public Works provided the traffic and fatal accident information for the intersection of Columbia Pike and Courthouse Road to Safety Board investigators. Table 1 summarizes this information, broken down by year, total accidents, injury accidents, fatal accidents, and pedestrian accidents.

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<sup>9</sup> While eastbound on Columbia Pike approaching the Courthouse Road intersection, the trash truck was traveling over a crest vertical curve. According to postaccident sight distance testing, the truck driver would probably have been able to see the school bus when the two vehicles were about 362 feet apart.

<sup>10</sup> The roadway conformed to American Association of State Highway and Transportation Officials (AASHTO) standards for urban principal arterial roads.

**Table 1.** Accident data summary for the accident intersection for the 3 years preceding the accident.

Year	Total accidents	Injury accidents	Fatal accidents	Pedestrian accidents
2002	5	1	0	0
2003	3	2	0	1
2004	6	2	0	2
Total	14	5	0	3

The speed limit for Columbia Pike in the vicinity of the accident is 30 mph. According to a postaccident speed survey of eastbound vehicles on Columbia Pike approaching the Courthouse Road intersection, conducted between noon and 1:00 p.m. on April 22, 2005, the 85th percentile speed<sup>11</sup> in this area was 35 mph for passenger cars and 40 mph for commercial vehicles. The Arlington County Police do not consider this location to have an unusual speeding problem. The speed of the eastbound trash truck at the time of the accident is unknown.

## Sideswipe Conditions

At the time of the accident, the bus was entering the center left turn lane. A tire mark on the edge of the centerline closest to the bus indicated that the bus's left front tire was touching this line, suggesting that the bus had initiated the movement into the turn lane but had not yet "straightened" the full body of the bus into and within it. If this movement were made later than would be optimal,<sup>12</sup> a portion of the bus's left front overhang might angle briefly over the centerline and into the eastbound lane. The incursion would last only until the sharp leftward movement was completed and the vehicle had fully readjusted its position back into and within the 10-foot-wide turn lane. (See figures 8 and 9.)

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<sup>11</sup> The *85th percentile speed* is the speed at which or below 85 percent of surveyed vehicles are traveling.

<sup>12</sup> A late turn would have to be more acute than one made at the beginning of the turn lane (at the point farthest from the intersection).



**Figure 8.** View from the rear of an exemplar school bus positioned as the accident bus is likely to have been immediately preceding the accident. (Photograph taken during postaccident reconstruction.)



**Figure 9.** View from the front of an exemplar school bus positioned as the accident bus is likely to have been immediately preceding the accident. Note that the bus's left-front corner is encroaching upon the eastbound lane. (Photograph taken during postaccident reconstruction.)

Witness reports and physical evidence suggest that leftward deviation from their lanes occurred for both vehicles, and the bus probably encroached slightly into the trash truck's lane, beyond the center lane marking. (See figure 10.) In other circumstances, such slight encroachment would probably have no consequences or, at worst, result in a minor sideswipe incident with few or no injuries. In this case, however, the outcome was different. The trash truck's loading arm struck the bus above its bumper and engine compartment (which provide some structural protection in most front-end collisions) and entered the bus's interior through the windshield. The destructive forces generated by the arm were small in terms of mass and had significant energy, which resulted in "tearing" damage to the bus's sidewall. The arm penetrated the left side of the bus to a depth of several inches, causing the most severe injuries resulting from this accident.



**Figure 10.** View of exemplar school bus and trash truck positioned as the accident vehicles are likely to have been immediately preceding the accident. (Photograph taken during postaccident reconstruction.)

The truck's loading arm was "down" with the fork cross shaft below the windshield, in general conformity with Heil's recommendations for a trash truck in transit from one pickup site to another. The alternative to having the arm in the down position while the truck is traveling is to keep the arm above the truck, as it would be when raising and emptying a dumpster. However, the accident trash truck traveling with the arm in this position would have been 22 inches taller than it would have been with the arm lowered; it would have had a height of 14 feet, 10 inches. Such a height could conflict with road height restrictions and put the truck at risk of striking overhead obstacles such as signage and bridges. AASHTO recommends that vertical clearances at



underpasses be at least 14 feet over the entire roadway width.<sup>13</sup> Some underpasses have less than the desired 14-foot vertical clearance.

## Trash Truck Driver

The trash truck driver, age 41, held a valid, unrestricted Virginia class B commercial driver's license (CDL), which had been renewed on June 25, 2003, with an expiration date of July 31, 2008. He had worked as a trash truck driver for 19 years. The driver's record showed one conviction for exceeding the posted speed limit by 1–9 mph in 2001 while operating his personal vehicle.

According to an October 22, 2003, medical certification examination report, the driver was in good general health and had no chronic or acute ailments, 20/20 vision, normal color vision, and normal hearing. The driver's account of his 72-hour history indicated that he had slept 8 3/4, 12 1/2, and 8 1/2 hours, respectively, the 3 nights preceding the accident.

Postaccident toxicology tests on blood specimens from the truck driver showed no evidence of drugs, including alcohol.

The trash truck driver had two cellular telephones in the vehicle, which were recovered by police on the scene. The police downloaded the data stored in both telephones and determined that neither was in use at or near the time of the collision.

During postaccident interviews, the truck driver stated that the school bus turned in to his vehicle. When informed that witnesses had indicated that the trash truck deviated from its travel lane toward the school bus, the truck driver stated that he believed his vehicle did not enter the bus's lane. Additionally, he said that as the bus was entering his lane, he observed the bus driver looking up in her mirror, at the children on the bus.

He stated that at the time of the accident he was not eating or drinking, he was not using a cellular telephone, and the sun was not blinding him.<sup>14</sup>

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<sup>13</sup> “Vertical clearance at underpasses should be at least 14 feet over the entire roadway width, with an additional allowance for future resurfacing.” See AASHTO's *A Policy on Geometric Design of Highways and Streets*, 5th edition (Washington, DC: AASHTO, 2004) 427.

<sup>14</sup> During a postaccident reconstruction of the accident conducted at 8:40 a.m. on April 24, 2005, investigators examined the effect of the sun's position on the view of the trash truck driver. The sun, which was above and to the right of the driver's eye reference position, was concealed from the driver's view by the structure of the truck cab above the windshield.

## **School Bus Driver**

The bus driver, age 37, held an unrestricted Virginia class B CDL, which had been renewed on January 27, 2003, with an expiration date of January 14, 2008.<sup>15</sup> She had worked as a school bus driver for 11 years and was driving her usual route at the time of the accident.

Arlington County school bus drivers receive behind-the-wheel training on both conventional and transit-style school buses before being permitted to drive for the county. They also receive annual refresher training before beginning work each school year. The training instructor for the school district stated that the accident bus driver had received her applicant training 11 years ago and that she had received her annual training before the beginning of the 2004–2005 school year. The training instructor also stated that drivers receive training about the implications of the dimensions of the transit-style school bus, especially the position of the driver with respect to the front wheel location during turning maneuvers.

The driver's record showed two previous convictions, one for exceeding the speed limit by 16–20 mph in her personal vehicle in 2003 and one for exceeding the speed limit by 11–20 mph (vehicle type was not identified) in 2001.

A review of the 2003 medical examination record for the bus driver revealed that she reported no adverse medical history or use of medications, and the physician's examination disclosed no disqualifying conditions.

Postaccident toxicology tests on blood specimens from the school bus driver showed no evidence of drugs, including alcohol.

The school bus was equipped with a two-way radio, which was disabled by the collision. The school bus driver had a personal cellular telephone in the bus. (Police did not recover the telephone following the accident.) No evidence was found to indicate that the driver was using either the two-way radio or the telephone at the time of the crash.

Investigators identified two issues concerning the bus driver—her work/rest schedule and her medical certification.

### ***Work/Rest Schedule***

The school bus driver declined to be interviewed by Safety Board investigators. Lacking interview information from the school bus driver, investigators could not determine when or how many hours she slept during the weekend preceding the accident.

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<sup>15</sup> At the time of the accident, the school bus driver's license was suspended for "financial responsibility infractions," due to failure to maintain insurance on her personal vehicle. The suspension was lifted shortly after the accident.

On Saturday, April 16, 2005, the school bus driver had begun a second job as a night stocker at a grocery store in Arlington, Virginia. She worked at the grocery store Saturday and Sunday, the two nights before the accident, between 11:00 p.m. and 6:00 a.m. On the day of the accident, a Monday, the school bus driver reported for her driving duties at 6:45 a.m. For the available information concerning the driver’s 72-hour history, see table 2.

**Table 2.** School bus driver’s known activities in the 72 hours preceding the accident.

Time	Actions
<b>Friday, April 15</b>	
6:45–9:45 a.m.	On duty, driving for Arlington County schools
2:00–5:00 p.m.	On duty, driving for Arlington County schools
<b>Saturday, April 16, through Sunday, April 17</b>	
11:00 p.m.–6:00 a.m.	First night of work at grocery store
<b>Sunday, April 17, through Monday, April 18</b>	
11:00 p.m.–6:00 a.m.	Second night of work at grocery store
<b>Monday, April 18</b>	
6:00–6:45 a.m.	Travel/preparation between end of grocery store duty and beginning of school bus driving duty
6:45–8:40 a.m.	On duty, driving for Arlington County schools; accident occurred at 8:40 a.m.

Because the school bus driver worked overnight shifts at her second job on the two nights preceding the accident, she may have been susceptible to the performance-impairing effects of circadian disharmony<sup>16</sup> at the time of the accident. Because any opportunity for the driver to rest during the 2 days before the accident would have been during daytime hours—a schedule the reverse of her previous nighttime sleep routine—the quantity and quality of such rest could have been reduced due to circadian disharmony. The effects of circadian disharmony can include slowed reaction time, reduced vigilance, and cognitive slowing. Such factors, perhaps coupled with distractions within the bus, reportedly caused by a falling clipboard and a student standing on a seat in the moments before the accident, could have negatively affected her driving performance.

<sup>16</sup> Circadian rhythm describes the regular recurrence, in cycles of about 24 hours, of biological processes or activities, such as sensitivity to drugs and stimuli, hormone secretion, sleeping, and feeding. This rhythm seems to be set by a “biological clock” that may be regulated by the recurring alternation between daylight and darkness. *Circadian disharmony* is experienced when the sleep/wake cycle is violated. (See M.R. Rosekind, *Fatigue in Transportation: Physiological, Performance, and Safety Issues*. Prepared for the National Transportation Safety Board, Washington, D.C., April 1999.)

The Arlington County School District was not aware that the bus driver had taken a nighttime job. The director of transportation for the district told investigators that at the time of the accident, the district had no policy requiring bus drivers to report outside jobs or to seek approval before accepting a second job with another employer. The director of transportation has since told Safety Board investigators that Arlington County school bus drivers are now required to report outside employment and that the district prohibits its school bus drivers from taking nighttime jobs.

Because it lacks information about the accident bus driver's 72-hour history, the Safety Board could not establish whether fatigue resulting from her nighttime job contributed to this accident. Nevertheless, it is concerned about the possible safety risks such jobs may pose for school bus drivers. The Board will provide articles for the publications of the National Association of State Directors of Pupil Transportation Services and the National Association for Pupil Transportation about the circumstances of this accident and the potential danger that permitting school bus drivers to hold nighttime jobs could reduce drivers' alertness and effectiveness as they perform their daytime driving duties.

### ***Medical Certificate***

During the investigation, Safety Board investigators identified an issue that did not have direct bearing on the accident<sup>17</sup> but nonetheless was of concern—a lapse in the medical certification of the school bus driver.

To drive a school bus in Virginia, an operator must possess a valid class B CDL and pass an annual physical examination. The Arlington County School District had contracted with a local health facility to conduct annual physical examinations of its bus drivers. At the time of the accident, the school bus driver possessed a Virginia physician's certificate issued November 21, 2003, which had expired on November 21, 2004, about 5 months before the accident. According to the records of the physician and school district, the driver had been scheduled to have an annual medical examination to renew her certificate on November 16, 2004, but the driver canceled the appointment. The appointment was not rescheduled.

Virginia State law<sup>18</sup> and the district's bus driver contract stated that bus drivers were to complete their medical certifications by the annual renewal date of their contracts. Bus driver contracts are renewed at the beginning of the school year. The accident bus driver's contract was renewed on August 30, 2004; consequently, her certification examination should have been conducted by that date. After the accident, the Arlington County School District transportation director told investigators that his

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<sup>17</sup> The Safety Board found nothing to suggest that medical factors negatively affected the school bus driver's behavior on the day of the accident.

<sup>18</sup> According to the *Code of Virginia*, Section 22.1-178, "Requirements for persons employed to drive school buses," Part D, medical examination documentation "shall be furnished annually prior to the anniversary date of the employment agreement as a condition to continuing employment to operate a school bus."

understanding had been that the medical certification examination had to be completed by the end, rather than the beginning, of the school year.<sup>19</sup>

Since the accident, the Arlington County School District has implemented a policy requiring that its school bus drivers submit a form signed by their physicians documenting that the annual medical exam has been completed in accordance with requirements, so that the district can verify the medical certification status of its drivers.

## **Probable Cause**

The National Transportation Safety Board determines that the probable cause of this accident was the school bus driver's encroachment into the trash truck's lane and the trash truck driver's failure to maintain proper lane position, for undetermined reasons, causing the front-left sides of the two vehicles to collide and the vehicles to sideswipe each other.

## **BY THE NATIONAL TRANSPORTATION SAFETY BOARD**

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**Adopted: December 21, 2007**

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<sup>19</sup> The transportation director had just returned after about a year of military service in Iraq when the accident occurred. During his absence, a temporary director had been carrying out his duties for the Arlington County School District.